

May 2023 Final Examination

Subject and Level	:	INORGANIC CHEMISTRY II
Subject Code	:	IORC102
Sapse Code	:	150416822
Duration of Examination	:	3 HOURS
Department	:	CHEMISTRY
Qualification	:	DIPLOMA - ANALYTICAL CHEMISTRY (ANCDIP)
Examiner(s)	:	DR N.E. DAMOYI
Moderator(s)	:	MR T. MPANZA
Full Marks	:	134
Total Marks	:	130
No. of pages (including cover page)	:	5

Date of Examination	:	06 JUNE 2023
Venue of Examination	:	DR SEME HALL
Time of Examination	:	09H00 – 12H00
Requirements	:	N/A
Instructions	:	ANSWER ALL QUESTIONS IN INK

DO NOT TURN OVER BEFORE PERMISSION IS GRANTED

QUESTION 1

- (a) Define the following terms from the Born-Haber cycle and state whether each is endothermic or exothermic:

(i) Lattice enthalpy change

(3)

(ii) Dissociation enthalpy change

(3)

- (b) Calculate the lattice enthalpy change (ΔH_L) of cesium chloride using the following data:



(3)

- (c) Draw Lewis-dot structures for the following molecules. Indicate the shapes resulting from the distribution of bond pair electrons and all electron pairs, and predict the hybrid orbitals used by the central atom and the bond angles for each case,

(i) NO_2F (the NO bonds are equivalent)

(5)

(ii) AsCl_3

(5)

(iii) PbO_2

(5)

- (d) Name the seven crystal systems in solids.

(7)

[31]

QUESTION 2

- (a) The weakest intermolecular forces that exist are the Van-der Waals type. Describe these forces and in your answers include examples of molecules with these forces.

(12)

- (b) Name the industrial process used to produce Na_2CO_3 . Use balanced equations to describe this process and give one use of Na_2CO_3 .

(12)

- (c) Devise a chemical method for separating a solution containing KNO_3 and $\text{Ba}(\text{NO}_3)_2$ to give two solutions/compounds each containing only one of the metal ions. Describe how you would identify the metal ions.

(7)
[31]

QUESTION 3

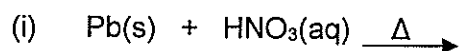
- (a) Give two reactions, one for the laboratory production and the other for the confirmation of hydrogen gas.

(4)

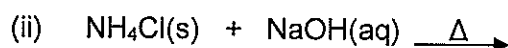
- (b) On treatment with cold water, an alkaline-earth metal (A) reacted vigorously, liberating a colourless, odourless gas (B) and solution (C). Lithium metal reacted with (B) yielding a solid product (D), which effervesced when mixed with water to give a strongly basic solution (E). When carbon dioxide was bubbled through solution (C), an initial white precipitate (F) was formed, which dissolved forming solution (G) when more carbon dioxide was added. Precipitate (F) effervesced when moistened with conc. HCl , and gave an apple-green colour to a Bunsen burner flame. Identify substances (A) to (G).

(7)

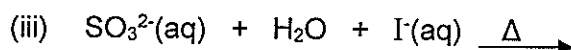
- (c) Complete and balance the following chemical reactions you conducted in your practical experiments:



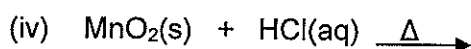
(2)



(2)



(2)



(2)

- (d) What is the natural main source of aluminium metal? Use balanced equations to describe the Bayer-Hall-Heroult process for the extraction of aluminium. What are the two functions of cryolite in the process?

(12)
[31]

QUESTION 4

- (a) Describe the inert-pair effect as observed in group 14 elements: Ga, In and Tl.

(4)

- (b) Consider the two common allotropes of C and contrast them under the following headings:
- (i) Allotrope names (2)
 - (ii) Bonding and crystal structure (5)
- (c) Describe, including equations, how you would produce and confirm the following gases in the laboratory:
- (i) CO_2 (3)
 - (ii) NH_3 (3)
 - (iii) SO_2 (3)
- [20]

QUESTION 5

- (a) Use balanced equations to describe the process for manufacturing nitric acid. Name this process. (8)
- (b) Show with two balanced equations that SO_2 and SO_3 are acid anhydrides of a weak acid and strong acid, respectively. Name the two acids. (4)
- (e) Show with an equation the disproportionation reaction of Cl_2 in water. The products are a weak acid and a strong acid, name the two acids. (4)
- (f) Name and describe the process for the preparation of chlorine gas from a melt of sodium chloride. (5)
- [21]

PERIODIC TABLE of the ELEMENTS

Atomic Number	Symbol	Relative atomic mass (atomic weight)
1	H	1.008
2	He	4.003

1s	1	2
2s	3	4
3s	11	12
4s	19	20
5s	37	38
6s	55	56
7s	87	88

3d	21	22	23	24	25	26	27	28	29	30
Sc	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39
4d	39	40	41	42	43	44	45	46	47	48
Y	88.91	91.22	92.91	95.94	(99)	101.1	102.9	106.4	107.9	112.4
5d	57	72	73	74	75	76	77	78	79	80
La	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6
6d	89	104	105	106	107	108	109			
Ac	(227)	Rf	Db	Sg	Bh	Hs	Mt			

2p	5	6	7	8	9	10
B	C	N	O	F	Ne	
10.81	12.01	14.01	16.00	19.00	20.18	
3p	13	14	15	16	17	18
Al	Si	P	S	Cl	Ar	
26.98	28.09	30.97	32.07	35.45	39.95	
4p	31	32	33	34	35	36
Ga	Ge	As	Se	Br	Kr	
69.72	72.61	74.92	78.96	79.90	83.80	
5p	49	50	51	52	53	54
In	Sn	Sb	Te	I	Xe	
114.8	118.7	121.8	127.6	126.9	131.3	
6p	61	62	63	64	65	66
Tl	Pb	Bi	Po	At	Rn	
204.4	207.2	209.0	(210)	(210)	(222)	

4f	58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
140.1	140.9	144.2	(145)	150.4	152.0	157.2	158.9	162.5	164.9	167.3	168.9	173.0	175.0	
5f	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	
232.0	(231)	238.0	(237)	(239)	(243)	(247)	(247)	(252)	(252)	(257)	(256)	(260)	(260)	

Value in brackets denotes the mass number of the most stable known isotope